1875MNRAS..36...76M

I have on the table an apparatus, a kind of Morse's telegraphic register, governed by a parabolic pendulum, which will illustrate my description. It is devised to draw a paper fillet over rollers with great uniformity for chronographic purposes.

On the Silvering of Glass by Inverted Sugar, for Optical Instruments and Experiments. By M. Adolphe Martin.

(*Communicated by Warren De La Rue, D.C.L., F.R.S.*)

Since my last publication of the process of silvering glass in *Les Mondes*, No. of 10th December 1868, I have found it useful to introduce the following modifications:—

We prepare four solutions, which, preserved apart, undergo no change:

1° A solution of 40 grammes of crystallised nitrate of silver, in a litre of distilled water.

2° A solution of 6 grammes of pure nitrate of ammonia, in 100 grammes of water.

3° A solution of 10 grammes of caustic potash (quite free from carbonate and chloride), in 100 grammes of water.

4° We dissolve 25 grammes of sugar in 250 grammes of water; we add 3 grammes of tartaric acid, and heat to boiling, which is maintained for about 10 minutes to produce the inversion of the sugar, and the solution is then allowed to cool. We then add 50 cubic centimetres of alcohol, to hinder any subsequent fermentation, and we dilute with water to make the volume half a litre if the silvering is to be done in winter, or dilute still more if it is to be done in summer.

We will take as an example the silvering of a mirror of ten centimetres diameter. On the surface of the glass, previously dusted with a brush of badger's hair, are poured a few drops of concentrated nitric acid, and, with the aid of a pad of fine carded cotton, free from extraneous substances, the glass is carefully cleaned, rinsed with water, and dried with a perfectly clean fine linen cloth. On the surface itself is made a mixture of about equal volumes of the potash solution (No. 3) and of alcohol, and this is used to clean the surface by means of a tuft of cotton. This liquid, of a somewhat syrupy consistence, has the property of wetting the glass without running off at the edge as other liquids would do. The surface thus covered is plunged into a vessel of tolerably pure water and well rubbed with a badger-hair brush to make the alkaline coating dissolve; the face is then turned downwards into a plate containing pure water, taking care that

1875MNRAS..36...76M

between the surface and the bottom of the plate there is a layer of water of at least $\frac{1}{2}$ a centimetre (which may be secured by supporting the mirror by three little wedges of wood or whalebone), and by a slight rocking we carry off the liquid of the preceding washing.

In a first graduated glass measure of suitable size we pour

15 cubic centimetres of the solution of nitrate of silver, No. 1.
15 cubic centimetres of the solution of nitrate of ammonia, No. 2.

Into a second glass measure:

15 cubic centimetres of the solution of potash, No. 3.
15 cubic centimetres of the liquid of inverted sugar, No. 4; and we pour this into the first glass.

This mixture is put into a small plate, and the mirror, which was left on the water, is brought rapidly and laid upon its surface. The mirror is kept at $\frac{1}{2}$ a centimetre from the bottom, as was done with the water; and is agitated gently by means of wedging in a continuous manner. If the liquids have been well prepared, the transparency of the first mixture is not impaired on pouring into it the mixture of potash and sugar. This definitive liquid ought, at the end of about half a minute, to colour itself, first pinkish yellow, then a yellowish brown, at last ink black. At this moment the silver begins to deposit itself on the border of the plate, with the colour of platinum; the glass then becomes silvered, in a very regular layer, without marked mottlings; we go on agitating it from time to time, and when the liquid, which has become turbid and greyish, covers itself with flakes of brilliant silver, the operation is finished. The mirror is removed and carefully washed under a sufficiently abundant stream of water, and after pouring quickly some distilled water over the surface, it is placed upon its edge on folded blotting paper and allowed to dry thoroughly. The surface then appears brilliant, but covered with a light bloom, which is easily removed by aid of a pad of chamois leather having upon its surface a little fine English rouge. *But if the potash is well freed from carbonate and the surface well cleaned, the silvering is perfectly brilliant and polished under this bloom, and it is not necessary to insist upon rubbing it with the pad.*

The principal accidents which may happen by reason of the inexact proportions of the mixtures are as follow:—If in the mixture of the nitrate of silver and the nitrate of ammonia the quantity of this last is insufficient, there will be on the addition of the mixture of potash and sugar a brown precipitate. If it is in excess, the silvering liquid will indeed remain clear, but it will colour itself by passing through violet tints; the white light reflected at the surface of separation of the glass and the liquid, before the silver appears, is coloured violet, and the silvering then produced is slow, very thin, dull, yellow for transmitted

1875MNRAS..36...76M

light, and it never attains a sufficient thickness. [When the ammoniacal solution is well proportioned the reflected image has brown tints; the silvering is produced at the end of about five minutes, and gives a layer which is blue by transmitted light, very brilliant by reflection]. Tints greenish by reflection, and persistent mottlings occur when the glass is not sufficiently cleaned. None of these inconveniences present themselves if the foregoing directions have been followed exactly. The presence of carbonate in the potash, if it is abundant, may give a white precipitate, which becomes very quickly coloured upon pouring in the sugar: the reducing action then takes place rather in the liquid than on the surface of the plate; even in small quantity the carbonate gives rise to dull flakes on the silver film, and the rubber never polishes them well.

The degree of concentration of the solution of silver is also important. If too weak, the action is slow and incomplete, but it is easy to increase the quantity during the course of the operation. If too strong, the action is too quick, and the reduction of silver takes place chiefly in the liquid; it is very difficult to moderate it. It is always proper to make a preliminary trial, inasmuch as the concentration of the reducing solution should vary with the exterior temperature. Lastly, in removing the mirror from the water in order to plunge it into the silvering solution, care must be taken that the water does not run off from the edge: the effect would be to produce on the circumference spots of dull and badly adhering silver.

Half-Silvering.—M. Léon Foucault has also, for certain experiments, proposed the process which he calls *half-silvering*. He accomplished it by his old process, and applied it specially to the observation of the Sun by aid of a refractor. The exterior surface of the object-glass which has received this half-silvering reflects into space the greatest part of the calorific rays, while the luminous rays continue their course so as to give rise to the ordinary image. The temperature of the image of the Sun furnished by such a glass is raised so little that a coloured glass introduced to diminish at pleasure the luminous intensity is not injured, as it would be if the object-glass were unsilvered.

The half-silvering may be obtained by the foregoing process, by stopping the operation as soon as the silver begins to appear upon the glass. The glass is removed out of the bath, washed well with water, and dried; but the rubber must not be applied. A few trials will show at what moment the glass should be taken out in order to obtain a silvering to reflect more or less light at the expense of the transmitted light.

(Extracted from *Les Mondes*, No. of 17th June 1875.)